◆ RIPARIAN AND RIVERINE AQUATIC HABITATS

INTRODUCTION

Habitats associated with shorelines of rivers and the Delta include riparian and shaded riverine aquatic habitat. Riparian vegetation includes scrub, woodland, and forest habitats that support a great diversity of wildlife species. Riverine aquatic habitat shaded by riparian vegetation, is important habitat for many species of fish, waterfowl, and wildlife.

Major factors that limit these habitats' contribution to the health of the Bay-Delta include historic riparian vegetation loss or degradation and near-shore aquatic habitat alteration from channelization, stabilization of channel banks with riprap, construction of levees, and control of flows.

Restoring riparian and riverine aquatic habitats will involve reactivating or improving natural physical processes. Natural streamflows, stream meanders, and sediment transport create and sustain these habitats and increase the complexity and structural diversity of the habitat. Natural streamflow patterns help sculpt healthy riparian and riverine aquatic habitats. High winter and spring flows trigger seed dispersal and germination, move sediment, stimulate stream meander, and flood and scour riparian and riverine habitat.

Natural stream channel meanders (often termed "meander belts") provide healthy, high-quality riparian and riverine aquatic habitats. Channelizing rivers (e.g., constructing levees), protecting banks (e.g., adding riprap), and channel dredging hinder natural stream meander and natural river channel morphology.

Natural sources of gravel and other sediments along rivers and floodplains provide materials needed to create and sustain healthy riparian and riverine aquatic habitats. Where improvement to physical processes do not adequately restore riparian and riverine habitats, direct modification may be necessary to restore habitats to their target acreage and quality.

Riparian and Riverine Aquatic Habitats are included in the MSCS description of *valley/foothill riparian habitat.* Valley/foothill riparian habitat includes all successional stages of woody vegetation generally dominated by willow, Fremont cottonwood, valley oak, or sycamore within the active and historical floodplains of low-gradient reaches of streams and rivers generally below an elevation of 300 feet. Valley/foothill riparian habitat includes portions of the ERP riparian and riverine aquatic habitat (Multi-Species Conservation Strategy 2000).

A major increase in floodplain riparian habitat will contribute sediment and nutrient to the rivers and estuaries. It will also improve the foodweb, and provide critical habitat for threatened and endangered terrestrial wildlife species, such as the yellow-billed cuckoo and Swainson's hawk. More extensive and continuous riparian forest canopy on the banks of estuaries and rivers will stabilize channels; help to shape submerged aquatic habitat structure; benefit the aquatic environment by contributing shade, overhead canopy, and instream cover for fish; and reduce river water temperature. More extensive and continuous shoreline vegetation associated with woody debris (branches and root wads) and leaf and insect drop in shallow aquatic habitats will increase the survival and health of juvenile salmonids, resident Delta native fishes, and introduced resident fishes. Achieving this objective will also greatly enhance the scenic quality and

recreational experience of our Delta and riverine waterways.

RESOURCE DESCRIPTION

Riparian habitats include the trees, shrubs, vines, herbaceous undergrowth, and organic material and snags along estuaries. These habitat elements combine to create the complex variety of species mixes, age classes, and distribution patterns common to shoreline vegetation. The landforms and changing fluvial streamflow patterns processes that create and interact with riparian vegetation are also an important but often overlooked part of the habitat.

Historically, the Central Valley floor had approximately 922,000 acres of riparian vegetation (Katibah 1984) supported by a watershed of more than 40,000 square miles. Today, approximately 100,000 acres of riparian forest remain. About half of this riparian habitat is in a highly degraded condition, representing a decline of 90% (Katibah 1984). The Sacramento River once supported 500,000 acres of riparian forest; it now supports 10,000-15,000 acres, or just 2-3% of historic levels (McGill 1979, 1987). From about 1850 to the turn of the century, most of the forest was destroyed for fuel as a result of the Gold Rush and river navigation, and by large-scale agricultural clearing.

Additional clearing in early and mid 1900s coincided with the aftermath of flood control reservoir and levee projects. These projects allowed ongoing clearing of floodplain riparian stands for orchards, crops, flood bypasses, levee construction, and urban areas. Similar patterns occurred along the San Joaquin River, which was also greatly affected when major portions of the river were dried up following construction of Friant Dam and other large reservoirs in the San Joaquin Basin. Resulting major changes in river flow conditions and sediment deposits triggered channel instability, and downcutting of rivers and streams that caused additional riparian and riverine habitat loss and fragmentation.

Riverine aquatic habitats comprise the relatively shallow submerged and seasonally flooded areas in estuary and river channel beds. Channel beds contain gravel beds, bars, and riffles; transient sandy shoals; waterlogged woody debris piles; and the shaded riverine aquatic habitat zone. The shaded riverine aquatic habitat is located where the river meets the riparian canopy. Riverine aquatic zones provide spawning substrate, rearing and escape cover, feeding sites, and refuge from turbulent stormflows for fish and other aquatic organisms.

The condition of riverine aquatic and nearshore habitats is not well documented for most of Central Valley and Delta estuaries, rivers, and streams. The condition of these habitats has been degraded by channel straightening; channel incising; channel dredging and clearing; instream gravel mining; riparian zone grazing; flow modifications; removal and fragmentation of shoreline riparian vegetation; and the loss of sediment, bedload, and woody debris from watershed sources upstream of dams.

Riparian and riverine aquatic habitats are created and sustained by natural fluvial processes associated with rivers. Fluvial dynamics are affected by the presence and pattern of riparian vegetation. Vegetation patterns define and contribute to riparian and riverine aquatic ecosystem structure and functions.

In general, riparian and riverine aquatic habitats are healthiest where ecosystem processes are in the most unaffected natural state. These sites are also the most resilient to human and natural disturbance. Ecosystem processes that are integral components of riparian and riverine aquatic habitats are described in greater detail in the ecosystem restoration visions for stream meander corridors, floodplains, natural geomorphology and sediment supply.

Sediment transport, deposition, and scour support, succession, and regeneration of riparian vegetation. These secondary processes require frequent high flow events in winter and spring. These frequent high flows redistribute sediment and bedload. After new vegetation is established on sediment bars and freshly deposited floodplains, the primary physical factors that sustain riparian vegetation are adequate streamflow, winter inundation of the floodplain, and shallow groundwater during the dry season.

Sediment transport and deposition, are also the processes that create and replenish riverine aquatic habitats. A high-quality aquatic habitat requires a continuous supply of sediment. Riverflows must periodically be high enough and of sufficient duration to move streambed materials.

Sediment deposits are shaped, in part, by riparian vegetation. Riparian vegetation resists flow and

causes fine sediment to aggrade within the dense stems. Riparian vegetation also redirects flows and causes the channel water to scour the bed. Scouring action forms pools, riffles, and bar patterns. Away from high-energy estuary channels, tidal mudflats form in broad, low-velocity areas when shoals of organic-rich fines are deposited.

Riparian vegetation serves many important ecological functions. Riparian vegetation absorbs nutrients and produces primary and secondary biomass at very high rates. This biomass feeds numerous fish and wildlife species. Birds and small mammals nest and take cover in the protective canopy foliage of trees. Trees also shade and cool floodplains and channels. Channel velocities are slowed by riparian foliage, allowing sediment to settle and create new landforms. Riparian foliage also stabilizes channels and banks, thereby rendering the characteristic geomorphology of estuaries, rivers, and streams.

Primary stressors affecting riparian habitats include:

- channel straightening and clearing;
- levee construction and bank hardening to protect bridge abutments and diversion structures (e.g., with riprap);
- instream gravel mining and riparian zone grazing;
- flow modifications affecting sediment transport and spring germination;
- removal, burning, and fragmentation of mature riparian vegetation; and
- loss of sediment and bedload from watershed sources upstream of dams.

Other stressors increasing in importance and magnitude include:

- displacement by invasive non-native trees and shrubs (e.g., tamarisk and giant reed),
- new expansion of orchards and vineyards into the riparian floodplain,
- human-set fires along river parkways,
- unusually high summer stage in rivers that supply increasing demand for downstream water diversions,
- groundwater lowered below the root zone, and
- expanded clearing of channel vegetation in response to recent flood events that called into question the capacity of levee-confined rivers and streams.

Most stressors have an indirect but lasting effect on the physical structure and post-disturbance recovery of streambed habitat. Collectively, these stressors have substantially reduced the quality and resilience of riverine aquatic habitats, thereby diminishing their effectiveness in providing for the life cycle requirements of fishes of the Delta and Sacramento and San Joaquin rivers and their tributaries.

VISION

The vision for riparian and riverine aquatic habitats is to increase their area and protect and improve their quality to assist in the recovery of special-status fish and wildlife populations and provide high-quality habitat for other fish and wildlife dependent on the Bay-Delta.

The vision includes restoring native riparian communities ranging from valley oak woodland associated with higher, less frequently inundated floodplain elevations to willow scrub associated with low, frequently inundated floodplain elevation sites such as streambanks, point bars, and inchannel bars.

The simple preservation of remaining natural riparian areas and riverine aquatic zones will not ensure the diversity, and resilience of these habitats. Preservation alone is not adequate because of the scarcity, degradation, and fragmentation of existing river and estuary systems. Most riparian restoration projects in the Central Valley have been implemented on a relatively small scale, primarily as mitigation for project impacts or infill of existing protected preserves. The National Research Council (1992) has recommended a national strategy for restoring rivers and aquatic ecosystems through integrated restoration of large landscape units.

If the floodplain, meander width, sediment supply, and natural spring flows are in place, the river will respond by creating natural landforms. These landforms will support self-sustaining vegetation communities and streambed habitats. Even partial restoration or simulation of natural physical processes

and floodplains will amplify ecosystem characteristics and resultant habitat quality. Rivers and Delta estuaries where natural fluvial processes and landforms are relatively intact need to be identified and highlighted as potential reserves of riparian and riverine habitat. Complete restoration on many segments may be limited by unalterable levee confinement and bridge crossings.

Restoring riparian and riverine aquatic habitat depends on recovery or simulation of natural fluvial processes and landforms. Revegetating and artificially altering stream channels will be considered only where overwhelming limitations prevent natural recovery of these physical processes and ecosystem functions.

LINK TO MSCS EVALUATED SPECIES

The MSCS has identified the following species as potentially benefitting from the restoration of riparian and riverine aquatic habitat in the Bay-Delta system:

MSCS SPECIES INCLUDED IN THE ERP

- Least Bell's vireo
- giant garter snake
- California red-legged frog
- valley elderberry longhorn beetle
- riparian brush rabbit
- little willow flycatcher
- western yellow-billed cuckoo
- Swainson's hawk
- San Joaquin Valley woodrat
- California yellow warbler
- western pond turtle, and
- foothill yellow-legged frog.

OTHER SPECIES EVALUATED IN THE MSCS

- bald eagle
- Alameda whipsnake
- ringtail
- white-tailed kite
- golden eagle
- greater western mastiff-bat
- yellow-breasted chat
- long-eared owl
- short-eared owl
- Cooper's hawk
- osprey
- double-crested cormorant
- marsh checkerbloom, and
- Delta coyote-thistle.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Efforts to achieve the vision for riparian and riverine aquatic habitats may involve coordination with other programs. These include:

- U.S. Army Corps of Engineers' proposed reevaluation of the Sacramento River flood control project and ongoing bank protection project, including more comprehensive floodplain management and river ecosystem restoration opportunities;
- SB1086 Advisory Council efforts and river corridor management plan for the Sacramento River;
- the San Joaquin River Parkway and Management plans;
- proposed riparian habitat restoration and floodplain management and riparian restoration studies for the San Joaquin River, including potential new flood bypass systems and expanded river floodplains on lands recently acquired by State and federal agencies and land trusts;
- ongoing Sacramento Valley conservation planning by The Nature Conservancy and other private nonprofit conservation organizations;
- expansion plans and conservation easements underway for the Sacramento River National Wildlife Refuge and California Department of Fish and Game's Sacramento River Wildlife Management Area;
- ongoing coordination efforts and programs of the Wildlife Conservation Board, including the Riparian Habitat Joint Venture;
- all county-sponsored instream mining and reclamation ordinances and river and stream management plans;
- and the California Department of Conservation reclamation planning assistance programs under the Surface Mining and Reclamation Act.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Riparian and riverine aquatic habitat used here is similar to the Goals Project (1999) description of riparian forest, willow grove, oak woodland, and mixed evergreen forest, Madrone Associates (1980) designations of riparian habitats including riparian woodland, riparian shrub-brush, brushy riprap, and herbaceous banks, and Cowardin's (1979) classifications of scrub/shrub wetland and forested wetland.

Riparian and riverine aquatic habitats are closely linked to the ecological health of many Ecological Management Zones and Units. This type of habitat is important to many fish, wildlife, and plants species and communities. It is adversely affected by many stressors that include levee construction, gravel mining, flow patterns, fragmentation of existing stands of riparian vegetation, competition and displacement by non-native plant species, land use and conversions, fires, lowered groundwater levels, and removal to increase flood control channel capacity.

OBJECTIVES, TARGETS ACTIONS, AND MEASURES

One Strategic Objective is to restore large expanses of all major aquatic, wetland, and riparian habitats, and sufficient connectivity among habitats, in the Central Valley and its rivers to support recovery and restoration of native species and biotic communities and rehabilitation of ecological processes.

Another Strategic Objective for riparian and riverine aquatic habitat is to restore large expanses of all major habitat types, and sufficient connectivity among habitats, in the Delta, Suisun Bay, Suisun Marsh, and San Francisco Bay to support recovery and restoration of native species and biotic communities and rehabilitation of ecological processes.

LONG-TERM OBJECTIVE: Restore, protect and manage, on a self-sustaining basis throughout the watershed, multiple large areas containing all aquatic, wetland, and riparian habitat types in the Central Valley and its rivers to a substantial fraction of their pre-settlement areas or to a point where all at-risk species that depend on the habitats are no longer at risk.

SHORT-TERM OBJECTIVES: Systematically identify and locate the best remaining areas containing the aquatic, wetland, and riparian habitat types, and prioritize them for conservation. Develop and begin implementation of action plans for restoring significant examples of each habitat type.

RATIONALE: Moyle and Ellison (1991) and Moyle (1996) developed a scheme for classifying the aquatic habitats of California for the purposes of conservation. Other classification schemes of aquatic habitats also exist, as do schemes for classifying riparian and wetland habitats. Whatever the system, it is obvious that the diversity of aquatic habitats is declining in Central Valley watersheds, especially in lowland areas. Each habitat supports a different assemblage of organisms, and quite likely many of the invertebrates and plants are still unrecognized as endemic forms. Thus, systematic protection of examples of the entire array of habitats in the region provides some assurances that rare and unusual aquatic organisms will also be protected, preventing contentious endangered species listings.

STAGE 1 EXPECTATIONS: A classification system for riverine and riparian habitats that can be used as a basis for conservation actions will have been developed. Inventory of habitat types should be completed and areas prioritized for conservation actions. Restoration actions should be evaluated and initiated where feasible.

RESTORATION ACTIONS

General restoration targets for riparian and riverine aquatic habitat include acquisition of easements or in-fee title to 16,000 to 24,000 acres of riparian lands in the stream meander zone along the Sacramento River between Red Bluff and Colusa and the acquisition or protection of riparian corridors along most of the streams and rivers throughout the ERP Study Area.

Recovery and simulation of natural fluvial processes and landforms will be accomplished using the following integrated steps:

- locating setback levees to expand potential riparian floodplain;
- expanding the storage, detention, and bypass capacity of the Sacramento and San Joaquin River flood control project to allow natural expansion of riparian vegetation within levees and the Sutter and Yolo bypasses; and
- designating, acquiring title or easements for, and deliberately managing river corridor meander zones on appropriate rivers and stream throughout the Central Valley.

The following actions would restore or enhance sediment supply to rivers and streams:

- reduce bank hardening by creating meander zones and widening floodplains;
- analyze alternative approaches for water diversions and associated intake and screening facilities on the mainstem river to avoid hardening the bank in some sections of the river;
- remove small, nonessential dams on gravel-rich streams;
- eliminate mining in streams and on low floodplains near channels; and
- widen bridges to broaden out-of-bank flow and eliminate the need to riprap vulnerable bridge abutments.
- breach or remove nonessential levees restricting former tidelands that would capture sediment needed to create tidal mudflats and estuary landforms.

These measures will significantly increase the extent and distribution of shallow-water and nearshore habitats. These habitats are productive generators of the Delta foodweb and provide essential new rearing habitat for juvenile Delta and anadromous fish. Where Delta land elevations are suitable, levee systems can be set back or altered to allow out-of-bank shallow flooding during high flood stage. Floodplain inundation will also provide additional flood storage and moderation of peak flows to decrease the risk of flooding elsewhere in the Delta. Foodweb support, spawning and rearing habitat for native fish (e.g., splittail), would be further enhanced by altering levees.

Opportunities for reducing riparian habitat stressors include:

- phasing out instream gravel mining;
- designating and acquiring "stream erosion zones" to reduce the use of bank riprap and allow greater natural recolonization;
- designing biotechnical slope protection measures that allow riparian vegetation to be established within levees;
- phasing out or reducing livestock grazing in riparian zones;
- establishing conservation easements for purchase of land or using other incentives to reduce or eliminate cropland conversion of riparian forest;
- eliminating or modifying programs which remove large woody debris from stream channels and rivers;
- identifying levee-confined channels and banks where routine vegetation removal by local reclamation districts can be safely discontinued; and
- establishing weed control programs to suppress the expansion of tamarisk, giant reed, locust, and other invasive non-native plants degrading habitat quality and native flora.

Opportunities for reducing stressors affecting riverine aquatic habitat include:

- phasing out instream gravel mining, especially downstream of dams and on streams that support salmon and steelhead spawning;
- designating and acquiring "stream erosion zones" to reduce the use of bank riprap and allow natural meander patterns;
- designing slope protection measures that allow shoreline riparian vegetation to be established within levees;
- phasing out or reducing livestock grazing in riparian and aquatic zones, especially on tributary streams that support salmon and steelhead spawning; and
- identifying levee-confined channels and banks where routine channel clearing and grading can be safely discontinued.

Reservoir operations will be evaluated to determine whether winter and spring releases can be augmented with flood simulation spikes every 1-10 years.

Simulated flood spikes would mobilize bed and bank deposits to redistribute, sort, and clean spawning gravels and scour deep pools between riffles.

Restoring riparian and riverine aquatic habitat should be accomplished by eliminating the stressors and recovering or simulating the physical processes and fluvial landforms described above. Habitat restored in this way will be more resilient to future disturbances; require little or no long-term maintenance; be self-sustaining; and be more compatible with flood control requirements.

However, habitat fragmentation and severe limitations of the physical environment will not allow ecosystem processes and functions to fully recover on many segments of valley streams and Delta estuaries. In these situations, some large-scale stream channel sculpting, gravel additions, and riparian replanting may be necessary. For example, the lower Sacramento River has abandoned river floodplains and sediment is in short supply. Naturally reactivating these habitats would be nearly impossible. Restoring these habitats would require human intervention. Revegetation projects should be contemplated only where native trees and grasses may no longer germinate naturally but have a high probability of unaided survival and vigorous growth following 1-5 years of artificial irrigation.

MSCS Conservation Measures

The following conservation measures were included in the Multi-Species Conservation Strategy (2000) to provide additional detail to ERP actions to enhance and restore riparian and riverine aquatic habitats that would help achieve species habitat or population targets.

- Provide suitable water quality (i.e., low concentration of pollutants) and substrates for delta smelt, longfin smelt, and splittail egg attachment (submerged tree roots, branches, rock, and emergent vegetation) to important spawning areas.
- Implement management measures identified in the proposed recovery plan for the Sacramento River winter-run chinook salmon.
- Coordinate protection and restoration of riparian habitats with other federal and state programs (e.g., U.S. Fish and Wildlife Service recovery plans, the SB 1086 program, and the Corps' Sacramento and San Joaquin Basin Comprehensive Study) that could affect management of occupied and historic habitat use areas to avoid potential conflicts among management objectives and identify opportunities for achieving multiple management objectives.
- Coordinate protection and restoration of riparian brush rabbit populations and its habitat with other federal and state programs (e.g., U.S. Fish and Wildlife Service recovery plans) that could affect management of occupied and historic habitat use areas to avoid potential conflicts among management objectives and identify opportunities for achieving multiple management objectives.
- Coordinate protection and restoration of San Joaquin Valley woodrat populations and its habitats with other federal and state programs (e.g., U.S. Fish and Wildlife Service recovery plans and the Corps' Sacramento and San Joaquin Basin Comprehensive Study) that could affect management of occupied and historic habitat use areas to avoid potential conflicts among management objectives and identify opportunities for achieving multiple management objectives.
- Coordinate protection and restoration of riparian habitat areas with other federal and state programs (e.g., the Riparian Habitat Joint Venture, the SB 1086 program, and the Corps' Sacramento and San Joaquin Basin Comprehensive Study) that could affect management of occupied and historic habitat use areas to avoid potential conflicts among management objectives and identify opportunities for achieving multiple management objectives.
- Coordinate protection and restoration of riparian habitats for the least Bell's vireo with other federal, state, and non-profit programs (e.g., the least Bell's vireo recovery plan team, Riparian Habitat Joint Venture, and the Corps' Sacramento and San Joaquin Basin Comprehensive Study) that could affect management of occupied and historic habitat use areas to avoid potential conflicts among management objectives and identify

opportunities for achieving multiple management objectives.

- Within the current range of valley elderberry longhorn beetle, design ERP riparian habitat enhancements and restorations to include suitable riparian edge habitat, including elderberry savanna.
- Initially direct ERP riparian habitat actions towards enhancement and restoration of habitat areas located near habitat occupied by valley elderberry longhorn beetle to encourage the natural expansion of the species range.
- Direct ERP actions proposed for the Stanislaus River towards protecting, enhancing, and restoring suitable riparian and associated flood refuge habitats for riparian brush rabbit and San Joaquin Valley woodrat in and adjacent to occupied habitat at Caswell Memorial State Park.
- Direct ERP actions proposed for the Stanislaus River towards protecting and enhancing existing occupied habitat areas; restoring suitable habitat adjacent to occupied habitat areas; and restoring suitable riparian habitat to create habitat corridors linking isolated populations of San Joaquin Valley woodrat.
- Consistent with Program objectives, protect existing suitable riparian habitat corridors from potential future changes in land use or other activities that could result in the loss or degradation of bank swallow habitat.
- A portion of restored riparian habitat area should be designed to include riparian scrub communities.
- Restore riparian habitats in patch sizes sufficient to discourage nest parasitism by brown-headed cowbirds.
- Proposed ERP actions to restore valley/foothill riparian habitat should initially be implemented in the Delta for Swainson's hawk.
- Initially restore suitable valley/foothill riparian forest and woodland under the ERP along at least 10 contiguous miles of channels in the Delta to create a riparian forest corridor at least 200 meters in width for western yellow-billed cuckoo.
- Restore large contiguous blocks of suitable valley/foothill riparian forest and woodland at least 200 meters in width and 500 acres in size along reaches of the Sacramento River adjacent to habitat occupied by the yellow-billed cuckoo (Red Bluff to Colusa).

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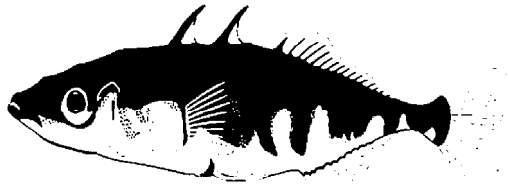
◆ FRESHWATER FISH HABITATS



INTRODUCTION

Freshwater fish habitats and native fishes are closely linked in the Central Valley as the health of native fish populations is largely dependent on the health of their habitats. The Sacramento-San Joaquin drainage system's large size, diversity of aquatic habitats, and isolation from other systems have provided a basis for freshwater fish speciation (Moyle 1976). Seventeen fish species evolved and live in the system. In addition, the diversity of habitats present in the Central Valley support a variety of native resident fish species, native anadromous species, native marine species, and an ever increasing number of introduced species.

The diversity of habitats include clear headwater streams that support rainbow trout, small warm tributaries and larger streams that flow through open foothill oak woodlands and support California roach, streams with average summer flows of 300 cfs or more and support squawfish, suckers, and hardheads, sluggish river channels, oxbow and floodplain lakes, and sloughs that support or supported Sacramento perch, hitch, and tule perch (Moyle 1976).

The designation of these habitats is important to allow the systematic protection of biological diversity within distinct geographic regions. The application of such a conservation-oriented classification system is of particular importance in the Central Valley where a rapidly growing human population and large tracts of irrigated agriculture compete with aquatic organisms for water (Moyle and Ellison 1991).

RESOURCE DESCRIPTION

Freshwater fish habitats complement the other habitats described in this volume. In general, the proposed freshwater fish habitat designations are based on a hierarchical classification system (Moyle and Ellison 1991) developed to provide a structure for conservation efforts and is based on fish distribution and endemism.

This classification system has additional utility as it assumes that observations of fishes are representative of less well-known aquatic organisms such as insects and amphibians.

Major habitat classifications for the Central Valley include standing waters, flowing waters, and artificial habitats.

Essential Fish Habitat is consistent with the MSCS designations of valley riverine and montane riverine aquatic habitats. Valley riverine aquatic habitat included the water column of flowing streams and rivers in low-gradient channel reaches below an elevation of approximately 300 feet that are not tidally influenced, including associated shaded riverine aquatic, pool, riffle, run, and unvegetated channel substrate (including seasonally exposed channel beds) habitat features, and sloughs, backwaters, overflow channels, and flood bypasses hydrologically connected to stream and river channels. Montane riverine aquatic has the same description as valley riverine aquatic except is includes the areas above 300 feet elevation.

STANDING WATERS

This classification included ephemeral waters such as floodplain and vernal pools, and permanent waters such as lakes, sloughs, oxbow lakes, and backwaters. Floodplain pools are shallow pools and ponds resulting from receding floodwaters of the Sacramento and San Joaquin rivers and their major tributaries. These waters often support fish and other aquatic organisms early in the season but can become detrimental as they gradually become too warm to support fish and typically evaporate by late summer.

Vernal pools in the Central Valley are northern claypan pools. They are shallow, temporary pools formed in depressions that hold winter and spring rainfall. These pools support a rich variety of

invertebrates and flowering plants. The larger pools may support tiger salamander and spadefoot larvae.

Permanent waters supporting fish are found throughout the Central Valley. These areas resulted from the meandering of the Sacramento and San Joaquin rivers which created oxbow lakes, backwater areas, and sloughs.

FLOWING WATERS

Flowing water fish habitats include the following classifications: resident trout streams, salmon-steelhead streams, and low elevation streams.

Resident trout streams include resident rainbow trout streams and rainbow trout/cyprinid streams. Resident rainbow trout streams are low order, cold, high gradient streams dominated by rainbow trout and riffle sculpins. Rainbow trout/cyprinid streams are small streams of moderate gradient supporting rainbow trout and one or more species of native minnows such as California roach or Sacramento sucker.

Salmon-steelhead streams include spring chinook streams and steelhead streams. Spring chinook streams are third to fifth order streams at elevations of 500-1500 m with deep canyons containing deep, cold pools that can sustain spring-run chinook salmon through the summer. Steelhead streams are second to fourth order streams used by steelhead for spawning and are dominated by juvenile steelhead.

Low elevation streams include valley floor rivers, fall chinook spawning stream, hardhead/squawfish streams, hitch streams, and California roach streams. Valley floor rivers include the main channels of the Sacramento and San Joaquin rivers, and the lower reaches of their tributary streams. Much of the flow is sluggish in summer and considerable cover is provided by woody debris and shaded riverine aquatic habitat. These low elevation streams flood seasonally and support a wide variety of fishes. Fall chinook salmon spawning streams are low elevation, low gradient tributaries to major rivers that dry up in summer but are used for spawning by both anadromous and resident fish species. Hardhead/squawfish stream are low- to mid-elevation streams characterized by deep, bedrock pools, clear water, and cool temperatures. The typical assemblage of fish include hardhead, Sacramento squawfish, and Sacramento sucker. Hitch streams are warm, low-elevation streams with low to moderate current and long reaches with sandy bottoms. Typical fish assemblages include hitch and

Freshwater Fish Habitats

Standing Waters
- ephemeral waters
  - floodplain pools
  - vernal pools
- permanent waters
  - lakes
  - sloughs
  - oxbow lakes
  - backwaters

Flowing Waters
- resident trout streams
  - resident rainbow trout streams
  - rainbow trout/cyprinid streams
- salmon-steelhead streams
  - spring chinook streams
  - steelhead streams
- low elevation streams
  - valley floor rivers
  - fall chinook spawning streams
  - hardhead/squawfish streams
  - hitch streams
  - California roach streams

Artificial Habitats
- ephemeral waters
  - rice paddies
  - wildlife refuges
  - drainage and evaporation ponds
  - seasonally irrigated lands
- permanent waters
  - cold water ponds
  - warm water ponds
  - ornamental ponds
  - cold water reservoirs
  - cool water stratified reservoirs
  - warm water reservoirs
  - run-of-river reservoirs
  - forebays
  - flooded pit lakes
- flowing waters
  - aqueducts
  - drainage ditches
  - irrigation ditches
  - flood control bypasses